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National Collegiate Athletic Association Injury Surveillance System Commentaries: Introduction and Methods

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Objective: To describe the history and methods of the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS) as a complement to the sport-specific chapters that follow.

Background: The NCAA has maintained the ISS for intercollegiate athletics since 1982. The primary goal of the ISS is to collect injury and exposure data from a representative sample of NCAA institutions in a variety of sports. Relevant data are then shared with the appropriate NCAA sport and policy committees to provide a foundation for evidence-based decision making with regard to health and safety issues.

Description: The ISS monitors formal team activities, numbers of participants, and associated time-loss athletic injuries from the first day of formal preseason practice to the final post-season contest for 16 collegiate sports. In this special issue of the *Journal of Athletic Training*, injury information in 15 colle-

giate sports from the period covering 1988-1989 to 2003-2004 is evaluated.

Conclusions: Athletic trainers and the NCAA have collaborated for 25 years through the NCAA ISS to create the largest ongoing collegiate sports injury database in the world. Data collection through the ISS, followed by annual review via the NCAA sport rules and sports medicine committee structure, is a unique mechanism that has led to significant advances in health and safety policy within and beyond college athletics. The publication of this special issue and the evolution of an expanded Web-based ISS enhance the opportunity to apply the health and safety decision-making process at the level of the individual athletic trainer and institution.

Key Words: athletics, sports, exposures, athletic injuries, injury mechanisms, injury rates, injury surveillance, practices, games

The National Collegiate Athletic Association (NCAA) and the National Athletic Trainers' Association (NATA) have partnered to publish this special issue in recognition of the 25-year relationship between these organizations in the collection and use of athletic injury information at the collegiate level. The NCAA Injury Surveillance System (ISS) is currently the largest collegiate athletic injury database in continuous operation in the world. The publishing of this volume (16 years of data from the 1988-1989 through 2003-2004 academic years for 15 sports) will provide a resource upon which to base safety and risk management decisions and to further injury prevention research. The *Journal of Athletic Training* is the appropriate venue for this information because the success of the ISS has always depended on the annual volunteer data collection efforts of hundreds of certified athletic trainers. These individuals are critical to the success of the system.

BACKGROUND: COLLEGIATE SPORTS AND THE NATIONAL COLLEGIATE ATHLETIC ASSOCIATION

The NCAA is an organization of colleges and universities established in 1906 in response to the concerns of President Theodore Roosevelt and college administrators about the numerous injuries and deaths occurring in the new sport of college football. The core purpose of the NCAA is to govern athletics competition in a fair, safe, equitable, and sportsman-

like manner and to integrate intercollegiate athletics into higher education.

The active member schools (1027 as of September 2004) self-determine in which of 3 divisions they will be classified and must annually meet the membership criteria for that division. Division I allows athletic scholarships and has certain sport sponsorship, scheduling, and game attendance requirements. Division II allows athletic scholarships (although fewer than Division I) and has fewer sport sponsorship and scheduling requirements and no minimum game attendance requirements. Division III allows no athletic scholarships and has fewer sport sponsorship requirements and no scheduling or game attendance criteria. The active member institutions and voting conferences are the ultimate voice in all NCAA policy, which is facilitated through more than 100 committees and an annual divisional legislative process.

Nationally, more than 375 000 student-athletes participate in NCAA sports that offer national championships.¹ Participation levels in NCAA men's sports have grown steadily over the past 2 decades. In 2003-2004, more than 217 000 male student-athletes were enrolled in NCAA member schools, up 28% from 1981-1982 (the earliest academic year for which comparable data exist). Participation in women's sports has risen even more dramatically over the same period. Nearly 163 000 female student-athletes were enrolled in 2003-2004, up nearly 120% from the 1981-1982 academic year. In 2003-2004, the

average NCAA member institution had approximately 366 student-athletes: 209 males and 157 females.¹ For more on the NCAA and its structure, see www.ncaa.org.

BACKGROUND: THE INJURY SURVEILLANCE SYSTEM

Recognizing its organizational health and safety roots, the NCAA has maintained the ISS for intercollegiate athletics since 1982. The primary goal of the ISS is to collect injury and exposure data from a representative sample of NCAA institutions in a variety of sports. Relevant data are then shared with appropriate NCAA sport and policy committees to provide a foundation for evidence-based decision making with regard to health and safety issues. A secondary goal of the system is to provide individual institutions with injury information that can be the foundation for their risk management decision making. Two examples of realistic applications of ISS data at the institutional level are assignment of athletic trainers to the activities of most risk and comparison of institutional injury rates with divisional and national totals.

Because the ISS is a surveillance system, with more variability than a smaller, well-controlled research study, the system may lack the sensitivity to monitor the effects of some policy changes on injury rates. In particular, the ISS collects a sample of data from a larger population, rather than acting as a registry, in which every occurrence of a particular event is reported. Therefore, rare but high-profile events, such as deaths or a well-publicized injury to a star player, may not be included in this database if the school associated with the event was not part of the sample. However, the consistency and longevity of the ISS, including stable basic system definitions and recording methods, provide a general foundation of collegiate sport injury risk across multiple sports that is an unmatched resource anywhere in the sports medicine literature. These data are the foundation for informed decision making and policy development at both the individual institution and national governing body and sport committee level.

Researchers sometimes use data from surveillance systems; however, not all surveillance systems are research studies. Because the primary function of the ISS has been specific to the aggregate monitoring of injuries in NCAA sports with no individual personal identifiers, the ISS has been classified as a nonresearch activity by the Centers for Disease Control and Prevention guidelines for much of its history.² However, independent investigators who analyzed and published research reports using ISS data, such as the anterior cruciate ligament studies noted in the next section, have received approval from their individual academic institution-based review boards. In 2003–2004, as part of the introduction of a new Web-based format, which included the option for personal identifiers, the system was reviewed and approved as meeting standards for human subject confidentiality by the NCAA Research Review Board. Consent forms for participants were developed to meet Health Information Portability and Accountability Act (HIPAA) and Family Education Rights and Privacy Act (FERPA) standards.

USE OF INJURY SURVEILLANCE SYSTEM DATA FOR RESEARCH AND PREVENTION

As noted above, the aggregate national data containing selected information over multiple years are annually shared

with appropriate NCAA sport rules committees and the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports. This information is used as a foundation for health and safety policy development. Select examples of the application of ISS data to NCAA health and safety policy include the following:

- 1995 analysis of concussion injuries in men's ice hockey that led to rule changes and officiating emphasis on reducing hitting from behind and contact to the head in the sport;
- 1997 modifications of permissible equipment and contact in spring football practices to reduce injury risk;
- 2003 modifications of permissible equipment and multiple practice days in preseason fall football practices to reduce heat illness and general injury risk;
- 2003 addition of required protective eye wear in women's lacrosse to reduce the small but real risk of significant eye injury; and
- 13-year analysis of noncontact anterior cruciate ligament injuries in basketball and soccer players that led to a focus on prevention efforts for female athletes, who have a higher risk for these types of injuries than their male counterparts.

The data also have been used by authors of a variety of refereed journal articles comparing the risk of anterior cruciate ligament injuries between male and female collegiate basketball and soccer players,^{3,4} assessing injury rates in spring and fall football practices,⁵ and evaluating the risk of bleeding and possible human immunodeficiency virus (HIV) transfer in college athletes.⁶

DEFINITIONS

During the years covered in this special issue, the ISS collected data on injuries and exposures that occurred in organized practices and competitions from the first day of preseason to the final postseason competition. The injury and exposure variables were combined to calculate an injury rate. Definitions for reportable injuries, reportable exposures, injury rates, and seasons have been consistent, with one addition, as noted below, since the system's inception and are listed in the following paragraphs. In this issue, the terms *game*, *competition*, *contest*, and *match* are used interchangeably.

Injury

A reportable injury in the ISS was defined as one that (1) occurred as a result of participation in an organized intercollegiate practice or competition *and* (2) required medical attention by a team certified athletic trainer or physician *and* (3) resulted in restriction of the student-athlete's participation or performance for 1 or more calendar days beyond the day of injury. If an off day followed the injury event, athletic trainers were asked to assess whether the injured athlete would have been able to participate.

The injury definition was expanded in the 1994–1995 academic year to include any dental injury occurring in an organized practice or game, regardless of time loss.

Exposure

A reportable athlete-exposure (A-E) was defined as 1 student-athlete participating in 1 practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with that participation. Only

participants with actual playing time were counted as having game exposures. Preseason intrateam scrimmages were classified as practice, not competition.

Injury Rate

An injury rate is a measure of the incidence of injury, defined as the number of injuries in a particular category divided by the number of A-Es in that category. In the ISS, this value was expressed as injuries per 1000 A-Es. For example, 6 competition injuries during 563 competition A-Es resulted in an injury rate of $(6/563) \times 1000$, or 10.7 competition injuries per 1000 A-Es.

Seasons

The traditional collegiate sport season was used for data collection and was divided into the following 3 subcategories defined by the NCAA: (1) Preseason: all formal team practices and exhibition games conducted before the first regular season contest; (2) In (or regular) season: all practices and competitions from the first regular season competition through the last regular season competition; and (3) Postseason: all practices and competitions after the last regular season competition through the last postseason competition.

Academic Year

The academic year was defined as beginning July 1 and ending June 30. Therefore, any given academic year of data collection spanned 2 calendar years. Fall and spring sports usually had a window of data collection within 1 calendar year, but in this report, they are labeled according to the appropriate academic year. For example, soccer data collected from August 1998 through the last postseason game in early December 1998 were categorized as academic year 1998–1999. Winter sports usually had a window of data collection over 2 calendar years and were similarly categorized. For example, basketball data collected from October 1998 through the last postseason game in April 1999 also were categorized as academic year 1998–1999.

Time Loss

Time loss was defined as the time between the original injury and return to participation at a level that would allow competition participation. Because of the variability of interpretation of this measure, this variable was not used for analysis except for grouping injuries that restricted participation for 10 or more days. This measure was still susceptible to variability, particularly for injuries occurring near the end of the year, when time loss would have to be projected. However, it was used as a basic marker to help isolate the injuries that were the most severe.

SAMPLING AND DATA COLLECTION

Sports Sampled

Since 1988, the ISS has collected data from 5 fall sports (men's football, women's field hockey, men's soccer, women's soccer, and women's volleyball), 6 winter sports (men's basketball, women's basketball, women's gymnastics, men's gymnastics,

men's ice hockey, and men's wrestling), and 5 spring sports (men's baseball, men's football, women's softball, men's lacrosse, and women's lacrosse). Data collection for women's ice hockey began in the 2000–2001 academic year. For this publication, spring football data were included in the football chapter, and no data were reported on men's gymnastics due to a limited reporting sample (only 1 to 3 schools annually). In addition, data were unavailable for the fall sports of men's and women's soccer and field hockey in 2003–2004 because of pilot testing of overall ISS system enhancements in these sports. Individual institution sport sponsorship varies significantly within the NCAA. For example, in 2003–2004, 1022 schools sponsored women's basketball, 255 sponsored field hockey, and 86 sponsored women's gymnastics.

This publication does not contain data on junior varsity activities, club activities, any in-season individual conditioning or weight-lifting sessions, or most out-of-season or nontraditional season practice, game, or conditioning activities (eg, spring soccer or fall baseball). Spring football data are the only nontraditional season injury data reported because of the well-defined and limited practice scope of the activity.

Data Collection

Since 1988, approximately 250 different schools annually participated in ISS data collection through their certified athletic trainers. Participation in the NCAA ISS was voluntary and available to all NCAA institutions. Each spring, a letter requesting participation in the ISS was sent to the head athletic trainer at each NCAA member institution. Attached to each letter was a checklist of the sports covered by the ISS. The athletic training staff was asked to select 1 primary sport and any secondary sports for data collection in each of the 3 sport seasons (fall, winter, and spring).

The initial target sample was 10% of the schools from each of the 3 NCAA divisions that sponsored a particular sport. To achieve this target, all primary requests were accepted, and all secondary requests were randomly accepted until 15% of sponsoring schools were enlisted. This oversampling allowed for any subsequent inadequate participation and attrition. This sampling scheme was used in the ISS to attempt to balance the dual needs of maintaining a reasonably representative cross-section of NCAA institutions while accommodating the needs of the voluntary participants. Thus, the group of schools contributing data was a deterministic sample, rather than a random sample. This is an appropriate strategy for an injury surveillance system with a primary focus on monitoring trends and patterns of injury.⁷

Athletic trainers at selected schools were notified about assigned sports and were provided data collection instructions and a packet of injury and exposure forms. The instructions defined reportable injury and exposures and specifically described each exposure and injury question, including scenarios with appropriate answers. Participating athletic trainers were instructed to submit data from the first day of official preseason practice to the final day of any postseason competition. As noted above, no data were collected during out-of-season or nontraditional season activities except for the well-defined maximum 15-day spring football practice activity.

Injury Form

A 2-page injury form was completed and submitted via standard mail or fax to the NCAA for each reportable injury

(Appendix A). This form contained approximately 30 questions related to basic injury mechanism, when and where the injury occurred, body part injured, type of injury, measures of severity (time loss and need for surgery), and sport-specific questions (eg, position played and specific injury mechanisms, such as contact with a stick). If more than one body part was injured in the same injury event, a separate form was completed for each injury. No name or other personal identification (eg, Social Security number) was collected.

Exposure Form

A 1-page exposure form was submitted weekly to the NCAA by each participating school (Appendix B). This form summarized the number of practices and competitions; the average number of participants for each activity; the season (pre-season, regular season, or postseason); types of playing surface for each activity, if relevant; and the location of the competition (home or away). As noted previously, competition participants were counted only if they officially participated in some part of the competition. Exposure forms were submitted weekly, even if no reportable injuries occurred during that time period.

Data Aggregation and Participation Incentive

Forms received by the NCAA were entered into a database (created specifically for the ISS) via hand entry or, in later years, scanning technology. Other than the unique school code number and sport, no identifiers were present on either the injury or exposure forms. Two weeks after the end of the NCAA championship in a given sport, each school's data were reviewed to ensure compliance with the minimum number of submitted exposure weeks for games and practices (defined as at least 70% of possible weeks). Those schools meeting that criterion were included in the aggregate division and national samples. Each participating school in the national sample received a hard copy of its own data, as well as copies of the appropriate division and national samples for the given academic year. A summary book containing selected injury data across all the years of data collection also was distributed to participating schools for reporting of basic trends. As a further incentive, a small monetary stipend was provided to the person in charge of data collection for each sport that qualified to be in the national sample.

INCLUSION CRITERIA FOR THIS PUBLICATION (DATA CLEANING AND FILTERING)

A minimum number of exposure weeks was the inclusion criterion for previously published ISS data. However, as data were being prepared for this special issue, a more thorough and systematic process was created to filter the more than 200 000 injuries and 1 400 000 exposure records in the ISS database. This filtering process for exposure data included 2 steps. The first involved the number of participants for a given event (game or practice), and the second involved the actual number of reported games and practices.

Number of Participants

After we ensured that the 70% of expected exposure weeks criterion was met, minimum and maximum numbers (boundary values) of expected participants were defined for practice

Table 1. Number of Participants by Sport, Activity, and Lower Acceptable and Upper Acceptable Limits (Boundary Values)*

Sport	Game or Practice	Mean	SD	Acceptable Limits	
				Lower Limit	Upper Limit
Men's baseball	Game	13.4	2.9	9	20
	Practice	27.8	6.9	12	50
Men's basketball	Game	10.5	1.9	7	15
	Practice	14.3	3.5	7	26
Women's basketball	Game	10.2	1.8	7	15
	Practice	12.3	2.7	7	24
Women's field hockey	Game	15.0	2.4	11	22
	Practice	21.2	5.8	11	35
Men's football	Game	50.0	9.5	24	90
	Practice	86.8	22.6	25	160
Men's spring football	Practice	73.5	18.2	30	120
Women's gymnastics	Game	9.8	2.5	1	15
	Practice	12.2	3.0	5	24
Men's ice hockey	Game	19.2	1.3	14	22
	Practice	26.1	4.4	12	40
Women's ice hockey	Game	17.6	2.8	12	23
	Practice	20.6	4.4	12	29
Men's lacrosse	Game	23.0	5.8	11	35
	Practice	30.7	8.6	12	50
Women's lacrosse	Game	16.3	3.0	11	25
	Practice	21.0	5.4	10	40
Men's soccer	Game	16.1	2.7	11	22
	Practice	23.1	5.6	11	40
Women's soccer	Game	15.9	2.7	11	22
	Practice	20.1	4.6	11	40
Women's softball	Game	11.8	1.9	9	18
	Practice	18.5	3.5	10	30
Women's volleyball	Game	9.6	1.7	6	15
	Practice	12.6	3.8	6	30
Men's wrestling	Game	10.0	3.5	1	17
	Practice	20.4	7.9	5	47

*Exposures with participant numbers outside the acceptable limits were replaced with the mean value.

and contest by sport. These values took into account the variability within each sport and division and across time from factors such as changes in allowable squad size and travel squad size for away games. All reported exposure data for number of participants at a given event were compared with the appropriate boundary values. The mean number of participants in each sport and event type (practice or game) were calculated for all exposures that fell within the defined boundaries. These means were then used to replace all exposure records that had participation values outside the acceptable boundaries (most likely due to key-punch error, eg, 100 instead of 10 for participants in a basketball game). Thus, all event records contained participant numbers that fell within the appropriate boundary values (Table 1). Fewer than 1% of all exposure data were modified in this process.

Number of Events

The average reported number of games and practices was calculated for each sport, across all years, by division. Significant variability existed in the numbers of reported practices and games as a result of factors such as different institutional, conference, and division season lengths and no standard number of required games or practices. This variability occurred at the sport level within division (eg, conferences may have

Table 2. Average Number of Game and Practice Events per School Year*

Sport	Games per Year (Divisions I, II) Average Value/70% of Average	Practices per Year (Divisions I, II) Average Value/70% of Average	Games per Year (Division III) Average Value/70% of Average	Practices per Year (Division III) Average Value/70% of Average
Men's baseball	45/31	50/35	32/22	50/35
Men's basketball	27/19	86/60	24/17	71/50
Women's basketball	26/18	83/58	23/16	64/45
Women's field hockey	18/12	49/35	17/12	40/28
Men's football	11/7	77/54	9/6	67/47
Men's spring football	N/A	14/10	N/A	N/A
Women's gymnastics	11/8	99/70	9/7	85/60
Men's ice hockey	34/24	90/63	25/17	66/46
Women's ice hockey	31/22	83/58	22/15	60/42
Men's lacrosse	12/9	60/42	13/9	54/38
Women's lacrosse	14/10	56/39	13/9	46/32
Men's soccer	17/12	51/35	16/12	45/32
Women's soccer	17/12	50/35	16/11	42/29
Women's softball	43/30	49/34	29/20	44/31
Women's volleyball	30/21	60/42	29/20	43/30
Men's wrestling	19/13	92/65	17/12	70/49

*Schools reporting <70% of the average number of games or practices for that sport in that division were excluded. N/A = not applicable.

different numbers of required games and no standard required number of practices), across divisions (eg, legislation differs on the maximum and minimum numbers associated with these events), and over time (eg, legislation changes in each division over time, particularly regarding season length and postseason opportunities). To account for this variability, any individual school academic year record (ie, school/sport/academic-year record) that reported at least 70% of the average number of practices and number of games for that sport in that division was included in the database reported in this publication (Table 2). If either the number of reported games or the number of reported practices did not meet the 70% criteria for that division in that sport, the injury and exposure data for that sport record were not included in this analysis. This enhanced filtering ensured that only the most complete season records were used in the analysis and in this publication. After an initial review of the data, we decided to combine Division I and Division II data in determining the average number of participants and events. These divisions, with similar regulations, including the use of athletic scholarships, generally had less variability in season length and number of activities than Division III.

Injuries

Accumulating more than 200 000 injury and 1.4 million exposure records over 16 years from hundreds of schools with multiple and changing data collectors resulted in expected variability in defining injury events. In order to reduce this variation and increase the sample size for relevant categorical analysis, we performed the following evaluation and recoding:

- Data collectors were instructed to choose the response option "Other" and to submit an alternative answer for the categories of body part and injury type when the specific responses were not appropriate. These "Other" responses were either assigned a defined category (using other information in the injury record), left as is, or, if frequent enough, used to create new categories (eg, headache, rotator cuff injury). We recognize that these newly created categories were underreported.
- Any athlete sustaining more than 1 soft tissue injury to the same body part at the same time had that injury counted only once, with additional injury detail being recorded in separate fields. For example, if an athlete sustained anterior cruciate ligament and meniscus tears during the same event, 1 injury was counted ("knee internal derangement"), and the specific structures injured were recorded as separate variables.
- The 6 injury mechanism responses were collapsed into 3 basic categories: contact with another person, other contact (including contact with playing surface, contact with playing apparatus, or contact with other [wall, fence]), and no contact (including no apparent contact: rotation about a planted foot and no apparent contact: other).
- The time-loss grouping categories used to record the number of days lost as a result of injury varied among sports. In order to ensure comparability, the time-loss variable was dichotomized into either less than 10 days or 10 days or more (including catastrophic and fatal). Ten days of time lost was considered to be a reasonable cutoff for distinguishing less severe injuries from more severe injuries.
- "Knee internal derangement" included any isolated or combination of anterior cruciate ligament, posterior cruciate ligament, collateral ligament (medial or lateral, not differentiated), or meniscus (medial or lateral, not differentiated) injury.
- All patellar injuries classified as knee injuries were reclassified as "patellar injuries."
- All heat illness events were recoded as "heat illness," even if heat exhaustion or heat stroke was the listed definition. Muscle cramps that could be associated with heat illness also were recoded into this category.
- Shoulder injuries categorized as meniscal tears were reclassified as labral tears. Because labral tears were not a specific option in the ISS, these injuries may have been reported in a variety of ways and likely are underrepresented.
- All subluxations and dislocations were combined.
- All complete and incomplete ligament injuries (ie, sprains) were combined.
- All complete and incomplete muscle-tendon injuries (ie, strains) were combined.

- All concussions were combined (ie, collapsing the grade I, grade II, and grade III classifications).
- All abrasions and contusions were combined and labeled "contusions."
- All lacerations and punctures were combined and labeled "lacerations."

Inclusion Criteria Summary

This process resulted in a standardized sample that met minimum values in both practice and game participants and numbers of practices and games. Participation and event filtering and injury evaluation resulted in an elimination of approximately 9% of the injury and 4% of the exposure records, resulting in a usable database of more than 182 000 injury and 1 300 000 exposure records. A total of 83% of the injuries were categorized as new, whereas 17% were categorized as recurrent.

DATA ANALYSIS AND PRESENTATION

Statistical Analysis

Injury rates (number of injuries divided by number of A-Es) were computed per 1000 A-Es. Rates were reported using competition and practice exposures. Rate ratios comparing the competition rate to the practice rate were computed by dividing the competition rate by the practice rate. Rate ratios indicate the increased rate of injury associated with game participation relative to practice participation (ie, if the rate of injury in games was 5.0 times higher than the rate of injury in practices, then the competition-to-practice rate ratio would be 5.0). Rate differences (eg, the competition rate minus the practice rate) were also used.

Ninety-five percent confidence intervals (95% CIs) were computed for all rates, rate ratios, and rate differences. The 95% CIs provide information about the precision of each rate and can be used to determine if 2 rates differ statistically from one another. Rates based on smaller numbers of injuries generally have wider 95% CIs, indicating that less confidence should be placed in that rate.⁸ The 95% CIs for rates, rate ratios, and rate differences were computed using standard large-sample formulas.^{8,9}

Negative binomial regression was used to assess trends in the injury rates over time.¹⁰ Specifically, we used these models to estimate the average annual percentage decrease (or increase) in the injury rate, assuming a linear trend over time, along with a 95% CI and *P* value for linear trend. These trend analyses have several limitations. First, these trend statistics assess only linear trends in the injury rate and do not quantify nonlinear trends (such as an increase in the first half of the study period, followed by a decline in the second half). Second, the trend statistic should be interpreted with caution when the injury rate differs among divisions. Some divisions have grown more rapidly than others over time and, thus, a significant trend statistic may simply reflect temporal changes among divisions in the number of sponsoring schools. We also caution that the trend statistics are not standardized for temporal changes among divisions in the number of schools participating in the ISS. Third, over the 16-year period, advances in the diagnosis and identification of athletic injuries have occurred and awareness has increased within the sports medicine community about the importance of sports injury surveillance.

Thus, upward trends in the injury rate may be due, at least in part, to improvements in clinical practice or better reporting of injuries to the ISS over time, or both.

Negative binomial regression was also used to generate *P* values comparing the rates among divisions for competitions and practices and to compare injury rates among the preseason, in season, and postseason. Note that comparison of postseason rates to preseason and in-season rates was subject to selection factors, because teams that typically played in the postseason were probably systematically different from the other teams as a whole. In addition, postseason rates were more prone to random error, because of a smaller number of reporting teams.

Negative binomial regression is appropriate for the analysis of injury rates. We used negative binomial regression in preference to Poisson regression¹¹ because the injury rates exhibited more variation than expected under Poisson assumptions (ie, overdispersion).¹⁰ We did not use ordinary linear regression because that model assumes that the dependent variable is normally distributed, which is often not true for injury rates.¹⁰

Presentation

The methods described in this article are applicable to all chapters included in this supplement. Consistent definitions across sports and years and standardized injury rates allow for comparisons across sports as appropriate. All NCAA data are presented in aggregate format. Each chapter begins with a review of the sport participation changes over the study period. Initial analyses and results are reported by division and year. Subsequent analyses collapse data across division and year because, in most cases, variation is minimal. The resulting larger sample size provides more robust body part and injury type and injury mechanism data sets, which are the most important components of this publication. The following standard tables and figures appear in each chapter.

- School Participation Frequency: Number of schools participating in the ISS compared with all schools sponsoring the particular sport at the NCAA varsity level in each division during each academic year.
- Average Annual Games, Practices, and Associated Athlete-Exposures by Division: Average number of games, game exposures, practices, and practice exposures collapsed over academic years for each division.
- Game and Practice Injury Rates over Academic Years: All 3 divisions combined.
- Game and Practice Injury Rates by Division and Season: Game and practice injury rates collapsed over relevant academic years by division and season (preseason, in season, and postseason).
- Game and Practice Injury Frequency by Major Body Part: Overall frequency for head/neck, upper extremity (includes shoulder/clavicle through fingers), trunk/back (includes pelvis, hips, groin, and internal organs), lower extremity (includes upper leg through toes), and other/system (including non-localized events such as heat illness) injuries for games and practices (academic years and divisions combined).
- Most Common Game and Practice Injuries: Most common body part and injury type combinations in games and practices (academic years and divisions combined). All combinations that accounted for at least 1% of reported injuries over the sampling period are shown.

- Game and Practice Injury Mechanism: Percentage of injuries in games and practices resulting from player contact, other contact (including playing apparatus, ground, and boundary walls), and no-contact mechanisms (academic years and divisions combined). In select sports, additional figures provide a more detailed analysis of injury mechanism (eg, contact with the ground, contact with the ball). In these analyses, the injury mechanism is the action that was the primary direct contributor to the injury. For example, if someone fell due to player contact and sustained a knee abrasion from scraping the ground, the reported specific injury mechanism would be contact with the ground.
- Most Common Game and Practice Injuries Resulting in 10+ Days of Activity Time Loss: Most common game and practice injuries restricting participation for at least 10 days and most common mechanism of such injuries.
- Additional tables and figures. Selected sport-specific data (if applicable): These tables and figures highlight sport-specific injuries or mechanisms of interest.

The final section of each chapter contains expert commentary regarding the ISS results and their applications to safety and injury prevention in the specific sport.

SUMMARY: THE EVOLVING INJURY SURVEILLANCE SYSTEM

Athletic trainers and the NCAA have collaborated for 25 years through the NCAA ISS to create the largest ongoing collegiate sports injury database in the world. Data collection through the ISS followed by annual review through the NCAA sport rules and sports medicine committee structure is a unique mechanism that has led to significant advances in health and safety policy within and beyond college athletics. The publication of this special issue and the evolution of an expanded Web-based ISS enhance the opportunity to apply the health and safety decision-making process at the level of the individual athletic trainer and institution.

The ISS has evolved over the last 25 years from a collection of injuries that occurred during football to a comprehensive, 16-sport surveillance system. In 2004, after a thorough redevelopment process, the ISS was converted to a Web-based injury tracking system designed to be a primary institutional medical-legal record. The Web format allows real-time access to individual data and eliminates the duplication of maintaining institutional records while also sending information to the ISS. The system also allows institutions significantly better access and analysis capabilities for their individual schools, as well as for conference, division, and national aggregate data.

In 2005, the ISS was expanded to cover all NCAA championship and emerging sports (eg, women's rugby) as well as approximately 50 club and intramural activities. A treatment module was added to assist the athletic trainer in monitoring

and quantifying the treatments and modalities associated with recorded injuries. Application of this data collection platform for organizations outside the NCAA also is being considered. More information on the ISS can be obtained at www.ncaa.org/iss or by contacting the NCAA ISS staff at (317) 917-6222.

DEDICATION

We dedicate this issue to the late Tim Kerin, MS, MEd, ATC, Head Athletic Trainer at the University of Tennessee from 1977 to 1992. Tim formalized the relationship between athletic trainers and the NCAA Injury Surveillance System by inviting NCAA staff to the NATA national meetings in the late 1980s to encourage the sharing of research findings and the exchange of ideas. His initial efforts have led to mutual respect and collaboration between the 2 organizations.

ACKNOWLEDGMENTS

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Appendix A.

2003-04 Individual INJURY Form—Women's Volleyball

NCAA Injury Surveillance System

INJURY DEFINITION: A reportable injury in the ISS is defined as one that:

1. Occurs as a result of participation in an organized intercollegiate practice or contest;
2. Requires medical attention by a team athletics trainer or physician; and
3. Results in any restriction of the athlete's participation or performance* for one or more days beyond the day of injury.
4. Any dental injury regardless of time loss.

* See POINTS OF EMPHASIS.

School Code: _____

Select one: Fall season Spring season

1. **Year:**
(1) FR (2) SO (3) JR (4) SR (5) Fifth
2. **Age:** _____ years 4. **Weight:** _____ pounds
3. **Height:** _____ inches 5. **Date of injury:** _____
(month/day)

6. **Injury occurred during:**
- (1) Preseason (before first regular-season match)
 - (2) Regular season
 - (3) Postseason (after final regular-season match)
 - (99) Other: _____

7. **Injury occurred in:**
- (1) Competition—varsity
 - (3) Practice

8. **COMPETITION ONLY—Where did this injury occur?**
- (1) Home
 - (2) Away
 - (3) Neutral site
 - (99) Other: _____

9. **Injury occurred during:**
- Competition:** (1) Warm-up **Practice:** (7) First half
(2) Game 1 (8) Second half
(3) Game 2
(4) Game 3
(5) Game 4
(6) Game 5 (99) Other: _____

10. **This injury is a:**
- (1) New injury
 - (2) Recurrence of injury from this season
 - (3) Recurrence of injury from previous season (this sport)
 - (4) Complication of previous injury (this sport)
 - (5) Recurrence of other-sport injury
 - (6) Recurrence of nonsport injury
 - (7) Complication of other-sport injury

11. **Has student-athlete had unrelated injury recorded this season?**
- (1) Yes
 - (2) No

12. *Not applicable to this sport; proceed to next question.*

13. **How long did this injury keep student-athlete from participating in the sport? (If end of season, give best estimate.)**
- (1) 1-2 days
 - (2) 3-6 days
 - (3) 7-9 days
 - (4) 10 days or more
 - (5) Catastrophic, nonfatal
 - (6) Fatal

14. **This injury involved:**
- (1) Contact with another competitor
 - (2) Contact with playing surface
 - (3) Contact with apparatus/ball
 - (4) Contact with other in environment (e.g., wall, fence, spectators)
 - (5) No apparent contact (rotation about planted foot)
 - (6) No apparent contact (other)
 - (99) Other: _____

15. **Principal body part injured** (for 1-10, complete Head-Injury Information; for 31 or 32, complete Knee-Injury Information):

- | | |
|-----------------|----------------------------|
| (1) Head | (23) Spine |
| (2) Eye(s) | (24) Lower back |
| (3) Ear(s) | (25) Ribs |
| (4) Nose | (26) Sternum |
| (5) Face | (27) Stomach |
| (6) Chin | (28) Pelvis, hips, groin |
| (7) Jaw (TMJ) | (29) Buttocks |
| (8) Mouth | (30) Upper leg |
| (9) Teeth | (31) Knee |
| (10) Tongue | (32) Patella |
| (11) Neck | (33) Lower leg |
| (12) Shoulder | (34) Ankle |
| (13) Clavicle | (35) Heel/Achilles' tendon |
| (14) Scapula | (36) Foot |
| (15) Upper arm | (37) Toe(s) |
| (16) Elbow | (38) Spleen |
| (17) Forearm | (39) Kidney |
| (18) Wrist | (40) External genitalia |
| (19) Hand | (41) Coccyx |
| (20) Thumb | (42) Breast |
| (21) Finger(s) | (99) Other: _____ |
| (22) Upper back | |

HEAD INJURY (answer only if response in question 15 was 1-10)

16. **This student-athlete was diagnosed as having:**
- (1) 1° cerebral concussion. [No loss of consciousness, short post-traumatic amnesia (seconds up to two minutes).]
 - (2) 2° cerebral concussion. [Loss of consciousness (less than five minutes) and amnesia for up to 30 seconds].
 - (3) 3° cerebral concussion. [Loss of consciousness (more than five minutes) and extended amnesia.]
 - (4) No cerebral concussion
 - (5) Unknown

17. **Was a mouthpiece (MP) worn?**
- (1) MP worn—dentist-fitted
 - (2) MP worn—self-fitted
 - (3) MP not worn

18. **Type eye injury:**
- (1) Orbital fracture
 - (2) Cornea
 - (3) Ruptured globe
 - (4) Soft tissue
 - (99) Other: _____

KNEE INJURY (answer only if response in question 15 was 31 or 32)

19. **Circle ALL knee structures injured:**
- (1) Collateral
 - (2) Anterior cruciate
 - (3) Posterior cruciate
 - (4) Torn cartilage (meniscus)
 - (5) Patella and/or patella tendon
 - (6) None
 - (99) Other: _____

— Please Answer All Questions —

Appendix A (cont).

– Please Answer All Questions –

20. Primary type of injury (circle one):

- | | |
|--|--------------------------------------|
| (1) Abrasion | (16) Fracture |
| (2) Contusion | (17) Stress fracture |
| (3) Laceration | (18) Concussion |
| (4) Puncture wound | (19) Heat exhaustion |
| (5) Bursitis | (20) Heatstroke |
| (6) Tendinitis | (21) Burn |
| (7) Ligament sprain (incomplete tear) | (22) Inflammation |
| (8) Ligament sprain (complete tear) | (23) Infection |
| (9) Muscle-tendon strain (incomplete tear) | (24) Hemorrhage |
| (10) Muscle-tendon strain (complete tear) | (25) Internal injury (nonhemorrhage) |
| (11) Torn cartilage | (26) Nerve injury |
| (12) Hyperextension | (27) Blisters |
| (13) AC separation | (28) Boil(s) |
| (14) Dislocation (partial) | (29) Hernia |
| (15) Dislocation (complete) | (30) Foreign object in body orifice |
| | (31) Avulsion (tooth) |
| | (99) Other: _____ |

21. Did a laceration or wound that resulted in oozing or bleeding occur as a part of this injury?

- (1) Yes (2) No

22. Did this injury require surgery?

- (1) Yes, in-season (2) Yes, postseason (3) No

23. Describe the joint surgery:

- | | |
|----------------------------|---------------------------|
| (1) Arthrotomy | (3) Operative arthroscopy |
| (2) Diagnostic arthroscopy | (4) No joint surgery |
| (99) Other: _____ | |

24. Injury assessment (best assessment procedure):

- | |
|---------------------------------------|
| (1) Clinical exam by athletic trainer |
| (2) Clinical exam by M.D./D.D.S. |
| (3) X-ray |
| (4) MRI |
| (5) Other imagery technique |
| (6) Surgery |
| (7) Blood work/lab test |
| (99) Other: _____ |

25. Injury occurred during:

- | |
|--------------------|
| (1) Offensive play |
| (2) Defensive play |
| (3) Neither |

26. Type of surface:

- | |
|-------------------|
| (1) Wood |
| (2) Composition |
| (99) Other: _____ |

27. Injury was caused by:

- | |
|--|
| (1) Injured player coming down on another player |
| (2) Another player coming down on injured player |
| (3) Other contact with another player |
| (4) Contact with net |
| (5) Contact with standard |
| (6) Contact with floor |
| (7) Contact with ball |
| (8) Contact with out-of-bounds observers (team, fans, media, cheerleaders) |
| (9) Contact with out-of-bounds apparatus (tables, bleachers, cameras) |
| (10) No apparent contact |
| (99) Other: _____ |

28. Injured player's activity:

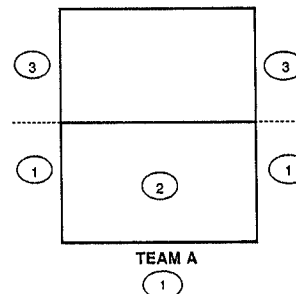
- | | |
|-------------|-------------------|
| (1) Serving | (5) Digging |
| (2) Spiking | (6) Blocking |
| (3) Setting | (7) Conditioning |
| (4) Passing | (99) Other: _____ |

29. Position played at time of injury (circle one):

- | |
|--|
| (1) Left front |
| (2) Center front (middle blocker) |
| (3) Right front |
| (4) Left back |
| (5) Center back (defensive specialist) |
| (6) Right back |
| (7) Nonpositional/conditioning drill |
| (99) Other: _____ |

30. Assuming the athlete plays for Team A, which number best represents where the injury occurred while she was playing the ball?

- | | |
|--|--------------------------|
| (1) Area 1 (outside Team A's court)? | <input type="checkbox"/> |
| (2) Area 2 (on court)? | <input type="checkbox"/> |
| (3) Area 3 (across center line, outside opponent's court)? | <input type="checkbox"/> |

**Additional comments (optional):** _____

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PRACTICE ONLY**31. Injury occurred during:**

- | |
|--------------------------|
| (1) A triple session day |
| (2) A double session day |
| (3) A single session day |
| (99) Other: _____ |

Appendix B.

2003-04 Weekly EXPOSURE Form—Women's Volleyball

NCAA Injury Surveillance System

EXPOSURE DEFINITION: An athlete exposure, the unit of risk in the ISS, is defined as one student-athlete participating in one practice or competition where he or she is exposed to the possibility of an athletics injury. Please report all weeks that include FORMAL team practices involving the entire team. Do not report optional or "captain's" practices.

Note: Please be as accurate as possible in reporting number of participants. PRACTICE participants must be included in a majority of the drills. GAME participants must have **actual playing time**. In most cases, the number of game participants is *less than* the number of practice participants.

School Code: _____ Week of: _____
(Sunday to Saturday)

Please answer all questions

PRACTICE

1. Number of practices this week
(Sunday to Saturday): _____
2. This week was part of:
 - (1) Preseason (before first regular-season contest)
 - (2) Regular season
 - (3) Postseason (after final regular-season contest; includes conference, regional and national tournaments)
3. Average number of participants per practice (see instructions): _____
4. Number of practices on wood surface: _____
5. Number of practices on composition (non-wood) surface: _____

VARSITY CONTEST

6. Was a varsity contest played?
 - (1) No (stop)
 - (2) Yes (go to next question)
7. Number of varsity contests: _____
8. For each varsity contest, provide the following information:

Contest No.	Total Number of Participants With Actual Playing Time (your team)	Location (check one)		Type of Surface (check one)	
		Home	Away	Composition (non-wood)	Wood
No. 1	_____	_____	_____	_____	_____
No. 2	_____	_____	_____	_____	_____
No. 3	_____	_____	_____	_____	_____
No. 4	_____	_____	_____	_____	_____
No. 5	_____	_____	_____	_____	_____